

Oil and Gas Extraction

(SIC 13)

SIGNIFICANT POINTS

- Most establishments employ fewer than 10 workers.
- About 60 percent of the industry's workforce is concentrated in 4 States.
- Although technological innovations have expanded exploration and development worldwide, employment is expected to decline.

Nature of the Industry

Petroleum, or oil as it is more commonly referred to, is a natural fuel formed from the decay of plants and animals buried beneath the ground for millions of years under tremendous heat and pressure. Formed by a similar process, natural gas often is found in separate deposits and sometimes mixed with oil. Because oil and gas are difficult to locate, exploration and drilling are key activities in the oil and gas extraction industry. Oil and natural gas furnish about three-fourths of our energy needs, fueling our homes, workplaces, factories, and transportation systems. In addition, they provide the raw materials for plastics, chemicals, medicines, fertilizers, and synthetic fibers.

Using a variety of methods, on land and at sea, small crews of specialized workers search for geologic formations that are likely to contain oil and gas. Sophisticated equipment and advances in computer technology have increased the productivity of exploration. Maps of potential deposits are now made using remote sensing satellites. Seismic prospecting—a technique based on measuring the time it takes sound waves to travel through underground formations and return to the surface—has revolutionized oil and gas exploration. Computers and advanced software analyze seismic data to provide 3-dimensional models of subsurface rock formations. This technique lowers the risk involved in exploring by allowing scientists to locate and identify structural oil and gas reservoirs and the best locations to drill. 4-D or “time-lapsed” seismic technology tracks the movement of fluids over time and enhances production performance even further. Another method of searching for oil and gas is based on collecting and analyzing core samples of rock, clay, and sand in the earth's layers.

After scientific studies indicate the possible presence of oil, an oil company selects a well site and installs a derrick—a tower-like steel structure—to support the drilling equipment. A hole is drilled deep in the earth until oil or gas is found, or the company abandons the effort. Similar techniques are employed in offshore drilling, except the drilling equipment is part of a steel platform that either sits on the ocean floor, or floats on the surface and is anchored to the ocean floor. Although some large oil companies do their own drilling, most land and offshore drilling is done by contractors.

In rotary drilling, a rotating bit attached to a length of hollow drill pipe bores a hole in the ground by chipping and cutting rock. As the bit cuts deeper, more pipe is added. A stream of drilling “mud”—a mixture of clay, chemicals, and water—is continuously pumped through the drill pipe and through holes in the drill bit. Its purpose is to cool the drill bit, plaster

the walls of the hole to prevent cave-ins, carry crushed rock to the surface, and prevent “blowouts” by equalizing pressure inside the hole. When a drill bit wears out, all drill pipe must be removed from the hole a section at a time, the bit replaced, and the pipe returned to the hole. New materials and better designs have advanced drill bit technology, enabling faster, more cost effective drilling, for longer lengths of time.

Advancements in directional or horizontal drilling techniques, which allow increased access to potential reserves, have had a significant impact on drilling capabilities. Drilling begins vertically, but the drill bit can be turned so drilling can continue at an angle of up to 90 degrees. This technique extends the reach, enabling a drill to reach separate pockets of oil or gas. Because constructing new platforms is costly, this technique is commonly employed by offshore drilling operations.

When oil or gas is found, the drill pipe and bit are pulled from the well, and metal pipe (casing) is lowered into the hole and cemented in place. The casing's upper end is fastened to a system of pipes and valves called a wellhead, or “Christmas Tree,” through which natural pressure forces the oil or gas into separation and storage tanks. If natural pressure is not great enough to force the oil to the surface, pumps may be used. In some cases, water, steam, or gas may be injected into the oil-producing formation to improve recovery.

Crude oil is transported to refineries by pipeline, ship, barge, truck, or railroad. Natural gas is usually transported to processing plants by pipeline. While oil refineries may be many thousands of miles away from the producing fields, gas processing plants usually are near the fields, so impurities—water, sulfur, and natural gas liquids—can be removed, before the gas is piped to customers. The oil refining industry is considered a separate industry and its activities are not covered here, even though many oil companies both extract and refine oil.

The oil and gas extraction industry has experienced both “boom” and “bust” in recent years. During the 1970s and early 1980s, the price of crude oil rose sharply, stimulating domestic exploration and production. Between 1970 and 1982—the year industry employment peaked—this industry created 438,000 jobs, a percentage increase that was more than four times greater than that of the economy as a whole. Employment rose twice as fast in the oil and gas field services segment than in crude petroleum, natural gas, and natural gas liquids segment, reflecting the fact that most exploration and drilling is done on a contract basis.

Starting in 1982, oil-producing countries around the world began yielding much larger volumes of crude oil, driving prices

down, culminating in the collapse of oil prices in the mid-1980s. During this time, the industry experienced a sharp decline in domestic exploration and production and an extended period of downsizing and restructuring, losing almost 390,000 jobs from 1982 to 1995. As was the case during the boom period, employment in oil and gas field services changed more than employment in crude petroleum and natural gas production.

Working Conditions

Working conditions in this industry vary significantly by occupation. Jobs as roustabouts and other production workers may involve rugged outdoor work in remote areas in all kinds of weather. For these jobs, physical strength and stamina are necessary. This work involves standing for long periods of time, lifting moderately heavy objects, and climbing and stooping to work with tools that are often oily and dirty. Executives generally work in office settings, as do most administrators and clerical workers. Geologists, engineers, and managers may split their time between the office and the job sites, particularly while involved in exploration work.

Only 1 employee in 20 works fewer than 35 hours a week, reflecting few opportunities for part-time work. In fact, a higher percentage of workers in this industry work overtime than in all industries combined. The average nonsupervisory worker worked 42.7 hours per week in 1998, compared to 34.6 hours for all workers.

Oil and gas well drilling and servicing can be hazardous. However, in 1997, the rate of work-related injury and illness in the oil and gas extraction industry, as a whole, was 5.9 per 100 full-time workers, somewhat lower than the 7.1 for the entire private sector. The rate for workers in oil and gas field services, 8.7 per 100 full-time workers, was nearly five times higher than for workers in crude petroleum and natural gas, which was only 2.0.

Drilling rigs operate continuously. On land, drilling crews usually work 6 days, 8 hours a day, and then have a few days off. In offshore operations, workers can work 14 days, 12 hours a day, and then have 14 days off. If the offshore rig is located far from the coast, drilling crew members live on ships anchored nearby or in facilities on the platform itself. Workers on offshore rigs are always evacuated in the event of a storm. Most workers in oil and gas well operations and maintenance or in natural gas processing work 8 hours a day, 5 days a week.

Many oil field workers are away from home for weeks or months at a time. Exploration field personnel and drilling workers frequently move from place to place as work at a particular field is completed. In contrast, well operation and maintenance workers and natural gas processing workers usually remain in the same location for extended periods of time.

Employment

The oil and gas extraction industry, with about 339,000 wage and salary jobs in 1998, is the largest industry in the mining division, accounting for more than one-half of employment. The workforce is divided between two segments: crude petroleum, natural gas, and natural gas liquids, with about 143,000 jobs, and oil and gas field services, with about 196,000 jobs.

Although onshore oil and gas extraction establishments are found in 48 States, about 60 percent of the industry's workers

in 1999 were located in just 4 States—California, Louisiana, Oklahoma, and Texas. While most workers are employed on land, many work at offshore sites. Although they are not included in employment figures for this industry, many Americans are employed by oil companies at locations in Africa, the North Sea, the Far East, the Middle East, South America, and countries of the former Soviet Union.

More than 7 out of 10 establishments employ fewer than 10 workers, although more than half of all workers in this industry work in establishments with 50 or more workers (chart).

Relatively few oil and gas extraction workers are in their teens or early 20s. Over 65 percent of the workers in this industry are between 35 and 54 years of age.

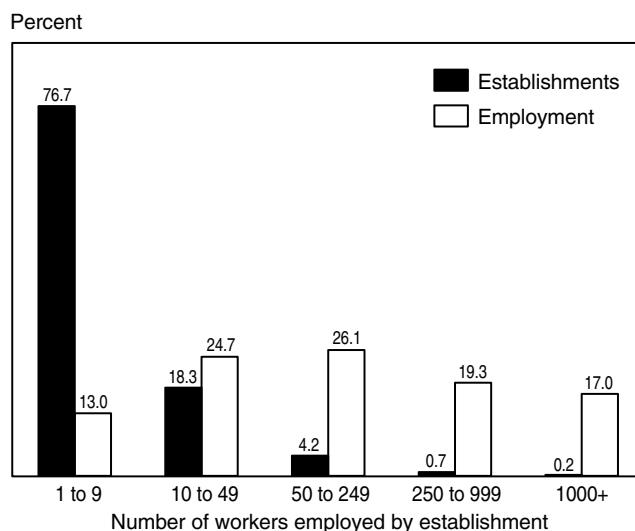
Occupations in the Industry

People with many different skills are needed to explore for oil and gas, drill new wells, maintain existing wells, and process natural gas. The largest group is production workers, accounting for nearly 44 percent of industry employment. Executive, managerial, and professional workers account for about 14 percent of employment; while clerical and administrative support workers account for about 11 percent (table 1).

A *petroleum geologist* or a *geophysicist*, who is responsible for analyzing and interpreting the information gathered, usually heads exploration operations. Other geological specialists, such as *paleontologists*, who study fossil remains to locate oil; *mineralogists*, who study physical and chemical properties of mineral and rock samples; *stratigraphers*, who determine the rock layers most likely to contain oil and natural gas; and *photogeologists*, who examine and interpret aerial photographs of land surfaces, may also be involved in exploration activities. Additionally, exploration parties may include *surveyors* and *drafters*, who assist in surveying and mapping activities.

Some geologists and geophysicists work in district offices of oil companies or contract exploration firms, where they prepare and study geological maps and analyze seismic data. These scientists may also analyze samples from test drillings.

More than 7 out of 10 establishments in oil and gas extraction employ fewer than 10 workers



Source: U.S. Department of Commerce, *County Business Patterns*, 1997

Other workers involved in exploration are *geophysical prospectors*. They lead crews consisting of *gravity and seismic prospecting observers*, who operate and maintain electronic seismic equipment; *scouts*, who investigate the exploration, drilling, and leasing activities of other companies to identify promising areas to explore and lease; and *lease buyers*, who make business arrangements to obtain the use of the land with owners of land or mineral rights.

Table 1. Employment of wage and salary workers in oil and gas extraction by occupation, 1998 and projected change, 1998-2008

(Employment in thousands)

Occupation	1998		1998-2008 Percent change
	Number	Percent	
All occupations	339	100.0	-16.7
Precision production, craft, and repair	148	43.7	-9.2
All other oil and gas extraction occupations	39	11.6	-1.1
Roustabouts, oil and gas	29	8.6	-21.6
Blue-collar worker supervisors	20	5.8	-13.4
All other extraction and related workers	14	4.1	4.1
Gas and petroleum plant and systems occupations	12	3.4	-8.9
Construction trades	9	2.6	-1.8
Industrial machinery mechanics	6	1.9	-13.7
Maintenance repairers, general utility	4	1.1	-27.7
Operators, fabricators, and laborers ..	58	17.1	-2.6
Material moving equipment operators ...	17	4.9	-22.7
Helpers, laborers, and material movers, hand	15	4.3	11.2
Hand workers, including assemblers and fabricators	13	3.9	5.9
Truck drivers	9	2.6	2.9
Executive, managerial, and administrative	46	13.6	-31.6
General managers and top executives	11	3.3	-20.4
Accountants and auditors	7	2.2	-44.0
All other managers and administrators	5	1.4	-28.9
Financial managers	3	0.8	-30.2
Administrative support, including clerical	36	10.8	-32.9
Secretaries	8	2.4	-42.3
General office clerks	9	2.8	-28.7
Bookkeeping, accounting, and auditing clerks	6	1.8	-41.9
Material recording, scheduling, dispatching, and distributing occupations	4	1.1	-14.8
Professional specialty	29	8.6	-32.0
Petroleum engineers	6	1.9	-21.6
Geologists, geophysicists, and oceanographers	6	1.8	-46.5
Computer systems analysts, engineers, and scientists	4	1.2	-7.1
Technicians and related support	14	4.1	-32.0
Science and mathematics technicians	7	2.0	-32.1
Engineering technicians	3	0.8	-21.7
Marketing and sales occupations	5	1.4	-7.9
All other occupations	2	0.8	-24.1

Petroleum engineers are responsible for planning and supervising the actual drilling operation, once a potential drill site has been located. These engineers develop and implement the most efficient recovery method, in order to achieve maximum profitable recovery. They also plan and supervise well operation and maintenance. *Drilling superintendents* serve as supervisors of drilling crews, supervising one or more drilling rigs.

Rotary drilling crews usually consist of four or five workers. *Rotary drillers* supervise the crew and operate machinery that controls drilling speed and pressure. *Rotary-rig engine operators* are in charge of engines that provide the power for drilling and hoisting. Second in charge, *derrick operators* work on small platforms high on rigs to help run pipe in and out of well holes and operate the pumps that circulate mud through the pipe. *Rotary-driller helpers*, also known as *roughnecks*, guide the lower ends of pipe to well openings and connect pipe joints and drill bits.

Though not necessarily part of the drilling crew, *roustabouts*, or general laborers, do general oil field maintenance and construction work, such as cleaning tanks and building roads.

Pumpers and their helpers operate and maintain motors, pumps, and other surface equipment that force oil from wells and regulate the flow, according to a schedule set up by petroleum engineers and production supervisors. In fields where oil flows under natural pressure and does not require pumping, *switchers* open and close valves to regulate the flow. *Gaugers* measure and record the flow, taking samples to check quality. *Treaters* test the oil for water and sediment and remove these impurities by opening a drain or using special equipment. In most fields, pumping, switching, gauging, and treating operations are automatic.

Other skilled oil field workers include *oil well cementers*, who mix and pump cement into the space between the casing and well walls to prevent cave-ins; *acidizers*, who pump acid down the well and into the producing formation to increase oil flow; *perforator operators*, who use subsurface "guns" to pierce holes in the casing to make openings for oil to flow into the well bore; *sample-taker operators*, who take samples of soil and rock formations from wells to help geologists determine the presence of oil; and *well pullers*, who remove pipes, pumps, and other subsurface devices from wells for cleaning, repairing, and salvaging.

Many other skilled workers—such as welders, pipefitters, electricians, and machinists—are also employed in maintenance operations to install and repair pumps, gauges, pipes, and other equipment.

In addition to the types of workers required for onshore drilling, crews at offshore locations also need radio operators, cooks, ships' officers, sailors, and pilots. These workers make up the support personnel who work on or operate drilling platforms, crewboats, barges, and helicopters.

Most workers involved in gas processing are operators. *Gas treaters* tend automatically controlled treating units that remove water and other impurities from natural gas. *Gas-pumping-station operators* tend compressors that raise the pressure of gas for transmission in pipelines. Both types of workers can be assisted by *gas-compressor operators*.

Many employees in large natural gas processing plants—*welders*, *electricians*, *instrument repairers*, and *laborers*, for example—perform maintenance activities. In contrast, many

small plants are automated and are checked at periodic intervals by maintenance workers or operators, or monitored by instruments that alert operators if trouble develops. In non-automated plants, workers usually combine the skills of both operators and maintenance workers.

Training and Advancement

Workers can enter the oil and gas extraction industry with a variety of educational backgrounds. The most common entry-level field jobs are as roustabouts or roughnecks, jobs that usually require little or no previous training or experience. Applicants for these routine laborer jobs must be physically fit and able to pass a physical examination. Companies also may administer aptitude tests and screen prospective employees for drug use. Basic skills can usually be learned over a period of days through on-the-job training. However, previous work experience or formal training in petroleum technology—that provides knowledge of oil field operations and familiarity with computers and other automated equipment—can be beneficial. In fact, given the increasing complexity of operations and the sophisticated nature of technology used today, employers now demand a higher level of skill and adaptability, including the ability to work with computers and other sophisticated equipment.

Other entry-level positions, such as engineering technician, usually require at least a 2-year technical school certificate. Professional jobs, such as geologist, geophysicist, or petroleum engineer, require at least a bachelor's degree and often a specialized graduate degree.

For well operation and maintenance jobs, companies generally prefer applicants who live nearby, have mechanical ability, and possess knowledge of oil field processes. Because this work offers the advantage of a fixed locale, members of drilling crews or exploration parties who prefer not to travel may transfer to well operation and maintenance jobs. Training is acquired on the job.

Promotion opportunities for some jobs may be limited due to the general decline of the domestic petroleum industry. Advancement opportunities for oil field workers remain best for those with skill and experience. For example, roustabouts may move up to switchers, gaugers, and pumpers. More experienced roughnecks may advance to derrick operators and, after several years, to drillers. Drillers may advance to tool pushers. There should continue to be some opportunities for entry-level field crew workers to acquire the skills that qualify them for higher level jobs within the industry. Due to the critical nature of the work, offshore crews, even at the entry level, generally are more experienced than land crews. Many companies will not employ someone who has no knowledge of oil field operations to work on an offshore rig, so workers who have gained experience as part of a land crew might advance to offshore operations.

As workers gain knowledge and experience, U.S. or foreign companies operating in other countries also may hire them. Although this can be a lucrative and exciting experience, it may not be suitable for everyone, because it usually means leaving family and friends and adapting to different customs and living standards.

Experience gained in many oil and gas extraction jobs also has application in other industries. For example, roustabouts

can move to construction jobs, while machinery operators and repairers can transfer to other industries with similar machinery. Geologists and engineers may become involved with environmental activities, especially those related to this industry.

Earnings

Average earnings in the oil and gas extraction industry were significantly higher than the average for all industries (table 2). Due to the working conditions, employees at offshore operations generally earn higher wages than workers at on-shore oil fields. College-educated workers and technical school graduates in professional and technical occupations usually earn the most. Earnings in selected occupations in oil and gas extraction appear in table 3.

Table 2. Average earnings of nonsupervisory workers in oil and gas extraction, 1998

Industry segment	Weekly	Hourly
Total, private industry	\$442	\$12.77
Total, oil and gas extraction	719	16.83
Crude petroleum and natural gas	945	22.66
Oil and gas field services	600	13.91

Few industry workers belong to unions. In fact, only about 4 percent of workers were union members or covered by union contracts in 1998, compared to about 15 percent of all workers throughout private industry.

Table 3. Median hourly earnings of the largest occupations in oil and gas extraction, 1997

Occupation	Oil and gas extraction	All industries
General managers and top executives ...	\$34.74	\$26.05
Accountants and auditors	22.73	17.66
First-line supervisors and supervisor/ managers-construction trade and extractive workers	21.70	18.28
Rotary drill operators, oil and gas extraction	14.44	14.41
Secretaries, except legal and medical	11.87	11.00
Derrick operators, oil and gas extraction	11.35	11.36
General office clerks	10.87	9.10
Service unit operators	10.28	10.31
Truck drivers, heavy or tractor-trailer	9.82	13.08
Roustabouts	8.73	8.75

Outlook

The level of future crude petroleum and natural gas exploration and development, and therefore, employment opportunities, remain contingent upon a number of uncertainties—most importantly, the future price of oil and gas. Sharply

higher prices mean companies, seeking greater profits, can be expected to implement new technologies, expand domestic exploration and production, and increase employment. Substantially lower prices, on the other hand, could make domestic exploration and continued production from many existing wells unprofitable, resulting in reduced employment opportunities.

In addition, environmental concerns, accompanied by strict regulation and limited access to protected Federal lands, continue to have a major impact on the industry. For example, environmental constraints, especially restrictions on drilling in environmentally sensitive areas, should continue to limit exploration and development, both onshore and offshore.

Overall employment in the oil and gas extraction industry is expected to decline 17 percent through the year 2008, even though worldwide demand for oil and gas is expected to remain strong. Employment in the crude petroleum, natural gas, and natural gas liquids segment of the industry is expected to decline about 46 percent, while employment in oil and gas field services—which includes all contract exploration and drilling services—is expected to increase by 5 percent.

While some new oil and gas deposits are being found in this country, especially in coastal waters, companies are increasingly moving to more lucrative foreign locations. As companies expand into other areas around the globe, the need for employees in the United States is reduced. However, advances in technology have increased the proportion of exploratory wells that yield oil and gas, enhanced offshore exploration and drilling capabilities, and extended the production of existing wells. As a result, more exploration and development ventures are profitable and provide employment opportunities that otherwise would have been lost.

Technological innovations, coupled with the declining cost of implementing such technologies, have reduced employment in many areas. Because overall employment is expected to decline, the need to replace workers who transfer to other industries, retire, or leave the workforce will be the sole source of job openings. Nevertheless, there is demand for qualified professionals and production workers who have significant experience in oil field operations and who can work with these new technologies. Employment opportunities will be best for those with previous experience and with strong technical skills. As employers develop and implement new technologies—such as 3-D and 4-D seismic exploration methods, horizontal and directional drilling techniques, and deepwater and subsea technologies—more workers capable of using sophisticated equipment will be needed.

Sources of Additional Information

Information on training and career opportunities for petroleum engineers or geologists is available from:

- Society of Petroleum Engineers, 222 Palisades Creek Dr., Richardson, TX. Internet: <http://www.spe.org>
- American Association of Petroleum Geologists, Communications Department, P.O. Box 979, Tulsa, OK 74101.

Information on some occupations in the oil and gas extraction industry may be found in the 2000-01 *Occupational Outlook Handbook*:

- Blue-collar worker supervisors
- Geologists geophysicists, and oceanographers
- Material moving equipment operators
- Petroleum engineers
- Truckdrivers